

EXHIBIT 10 21 NOV 1999

FORM PTO-1390 (Modified) (REV 10-95)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER 9847-0001-6X PCT
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371			U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR) 09/147325
INTERNATIONAL APPLICATION NO. PCT/SE97/00897	INTERNATIONAL FILING DATE 27 May 1997	PRIORITY DATE CLAIMED 29 May 1996 earliest	
TITLE OF INVENTION ROTATING ELECTRICAL MACHINE COMPRISING HIGH-VOLTAGE STATOR WINDING AND ELONGATED SUPPORT DEVICES SUPPORTING THE WINDING AND METHOD FOR MANUFACTURING SUCH MACHINE			
APPLICANT(S) FOR DO/EO/US Mats LEIJON, et al			
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:			
<ol style="list-style-type: none">1. <input checked="" type="checkbox"/> This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.2. <input type="checkbox"/> This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371.3. <input checked="" type="checkbox"/> This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).4. <input checked="" type="checkbox"/> A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371 (c) (2))<ol style="list-style-type: none">a. <input type="checkbox"/> is transmitted herewith (required only if not transmitted by the International Bureau).b. <input checked="" type="checkbox"/> has been transmitted by the International Bureau.c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US).6. <input type="checkbox"/> A translation of the International Application into English (35 U.S.C. 371(c)(2)).7. <input checked="" type="checkbox"/> A copy of the International Search Report (PCT/ISA/210).8. <input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))<ol style="list-style-type: none">a. <input type="checkbox"/> are transmitted herewith (required only if not transmitted by the International Bureau).b. <input type="checkbox"/> have been transmitted by the International Bureau.c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired.d. <input checked="" type="checkbox"/> have not been made and will not be made.9. <input type="checkbox"/> A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).10. <input type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).11. <input checked="" type="checkbox"/> A copy of the International Preliminary Examination Report (PCT/IPEA/409).12. <input type="checkbox"/> A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).			
Items 13 to 18 below concern document(s) or information included:			
<ol style="list-style-type: none">13. <input type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98.14. <input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.15. <input checked="" type="checkbox"/> A FIRST preliminary amendment. A SECOND or SUBSEQUENT preliminary amendment.16. <input type="checkbox"/> A substitute specification.17. <input type="checkbox"/> A change of power of attorney and/or address letter.18. <input type="checkbox"/> Certificate of Mailing by Express Mail19. <input checked="" type="checkbox"/> Other items or information:			
<div>Notice of Priority. Clean Copy of Specification (as amended by Preliminary Amendment) PCT/IB/304 Request For Consideration of Documents Cited in International Search Report</div>			

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR	INTERNATIONAL APPLICATION NO. PCT/SE97/00897	ATTORNEY'S DOCKET NUMBER 9847-0001-6X PCT
--------------------------------------------	--------------------------------------------------------	-----------------------------------------------------

20. The following fees are submitted: BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :				CALCULATIONS PTO USE ONLY	
<input type="checkbox"/> Search Report has been prepared by the EPO or JPO		\$930.00			
<input type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482)		\$670.00			
<input type="checkbox"/> No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2))		\$760.00			
<input checked="" type="checkbox"/> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO		\$970.00			
<input type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4)		\$96.00			
ENTER APPROPRIATE BASIC FEE AMOUNT =				\$970.00	
Surcharge of \$130.00 for furnishing the oath or declaration later than months from the earliest claimed priority date (37 CFR 1.492 (e)). <input type="checkbox"/> 20 <input checked="" type="checkbox"/> 30				\$130.00	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	78 - 20 =	58	x \$18.00	\$1,044.00	
Independent claims	4 - 3 =	1	x \$78.00	\$78.00	
Multiple Dependent Claims (check if applicable). <input type="checkbox"/>				\$0.00	
TOTAL OF ABOVE CALCULATIONS =				\$2,222.00	
Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) (check if applicable). <input type="checkbox"/>				\$0.00	
SUBTOTAL =				\$2,222.00	
Processing fee of \$130.00 for furnishing the English translation later than months from the earliest claimed priority date (37 CFR 1.492 (f)). <input type="checkbox"/> 20 <input type="checkbox"/> 30 +				\$0.00	
TOTAL NATIONAL FEE =				\$2,222.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable). <input type="checkbox"/>				\$0.00	
TOTAL FEES ENCLOSED =				\$2,222.00	
				Amount to be: refunded	\$
				charged	\$

- ☒ A check in the amount of **\$2,222.00** to cover the above fees is enclosed.
- ☐ Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees.
A duplicate copy of this sheet is enclosed.
- ☒ The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **15-0030** A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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Telephone Number (703) 413-3000
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SIGNATURE

Gregory J. Maier

NAME

25,599

REGISTRATION NUMBER

DATE

Nov. 25, 1998

IN RE APPLICATION OF: Mats LEIJON, et al

SERIAL NO.: New U.S. PCT Application based on PCT/SE97/00897

FILED: Herewith

FOR: ROTATING ELECTRICAL MACHINE COMPRISING HIGH-VOLTAGE STATOR WINDING AND ELONGATED
SUPPORT DEVICES SUPPORTING THE WINDING AND METHOD FOR MANUFACTURING SUCH MACHINE

ASSISTANT COMMISSIONER FOR PATENTS
WASHINGTON, D.C. 20231

Sir:

Transmitted herewith is an amendment in the above-identified application.

- ☒ No additional fee is required.
- ☐ Small entity status of this application under 37 C.F.R. §1.9 and §1.27 has been established by a verified statement previously submitted.
- ☐ Small entity status of this application under 37 C.F.R. §1.9 and §1.27 has been established by a verified statement submitted herewith.
- ☒ Additional documents filed herewith: Notice of Priority, Check for \$2222.00, PCT/IB/304, PCT Transmittal Letter, Clean Copy of Specification (as amended by Preliminary Amendment), Preliminary Amendment, International Search Report, International Preliminary Examination Report and Request For Consideration of Documents Cited in International Search Report

The fee has been calculated as shown below.


The fee has been calculated as shown below:

(Col. 1)		OTHER THAN A SMALL		(Col. 2)		(Col. 3)		SMALL ENTITY		ENTITY	
	CLAIMS REMAINING AFTER		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE	
TOTAL	*78	MINUS	*** 78	= 0		X11 =	\$		X22 =	\$.00	
INDEP	*4	MINUS	*** 4	= 0		X40 =	\$		X80 =	\$.00	
<input type="checkbox"/> FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM						+130=	\$		+260=	\$	
TOTAL							\$		TOTAL	\$.00	

A check in the amount of \$_____ is attached.

- XX Please charge any additional fees for the papers being filed herewith and for which no check is enclosed herewith, or credit any overpayment to deposit Account No. 15-0030. A duplicate copy of this sheet is enclosed.
- XX If these papers are not considered timely filed by the Patent and Trademark Office, then a petition is hereby made under 37 C.F.R. §1.136, and any additional fees required under 37 C.F.R. §1.136 for any necessary extension of time may be charged to deposit Account No. 15-0030. A duplicate copy of this sheet is enclosed.

OBLON, SPIVAK, McCLELLAND,
MAIER & NEUSTADT, P.C.



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*If the entry in Column 2 is less than the entry in Column 1 write "0" in Column 3.
**If the "Highest Number Previously paid for" IN THIS SPACE is less than 20 write "20" in this space.
***If the "Highest Number Previously paid for" IN THIS SPACE is less than 3 write "3" in this space.

09/147325

300 Rec'd PCT/PTO 27 NOV 1998

DOCKET 9847-0001-6X PCT

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF: :
MATS LEIJON ET AL : ATTENTION: APPLICATION BRANCH
SERIAL NO: NEW PCT APPLICATION :
(BASED ON PCT/SE97/00897)
FILED: HEREWITH :
FOR: ROTATING ELECTRICAL MACHINE
COMPRISING HIGH-VOLTAGE
STATOR WINDING AND ELONGATED
SUPPORT DEVICES SUPPORTING THE
WINDING AND METHOD FOR
MANUFACTURING SUCH MACHINE

PRELIMINARY AMENDMENT

ASSISTANT COMMISSIONER OF PATENTS
WASHINGTON, DC 20231

SIR:

Prior to an examination on the merits, please amend the above-identified PCT patent application as follows:

IN THE TITLE

Please change the title to read as follows:

--ROTATING ELECTRICAL MACHINE HAVING HIGH-VOLTAGE STATOR
WINDING AND ELONGATED SUPPORT DEVICES SUPPORTING THE
WINDING AND METHOD FOR MANUFACTURING THE SAME--

IN THE SPECIFICATION

Delete the following header on all pages "WO97/45935 PCT/SE97/00897".

After the title insert the following:

--BACKGROUND OF THE INVENTION

Field of the Invention:--

Page 1, line 4, delete "in a first aspect"; and line 4 through line 5, delete "of the type described in the preamble to Claim 1 or Claim 41";

line 8, after "machines" insert --and a method for making the same--;

lines 10 - 11, delete in their entirety;

line 12, insert --BACKGROUND OF THE INVENTION--;

line 13, change "application" to --document--;

line 15, change "application" to --document--;

line 24, change "Similar" to --Conventional", and delete "conventionally";

line 33, after "it" insert --may--; and

line 34, change "=" to --refers to--.

Page 2, line 9, change "vibration" to --vibrate--;

line 18, change "US-4 429 244, US-4 164 672 and US-3 743 867" to --U.S.

Patent No. 4,429,244; No. 4,164,672 and No. 3,743,867--,

line 25, after "This" insert --article--; same line, after "Parson" insert --in--;

and

line 35, after "US" insert --Patent No.--.

Page 3, line 8, after "having" insert --an--;

line 10, change "means" to --way--;

line 25, change "means" to --way--.

Page 4, line 13, change "A" to --In a --;

line 14, after "which a" delete --to--;

line 24, change "monolithe" to --monolith--;

line 30, change "an" to --a--; and

line 31, change "obvious" to --clear--.

Page 5, line 1, after "US" insert --Patent No.--; and

line 19, change "mains" to --main--.

Page 6, line 3, insert --Summary of the Invention--;

line 4, change "the object" to --an object--;

line 9, change "consists of" to --has--;

line 12, after "this" insert --problem--;

line 13, after "described" insert --herein--; and delete "in the preamble to claim 1 or claim 41 to special";

line 14, delete in its entirety; and

line 19, change "latter" to --insulating layer--.

Page 7, line 1, change "comprise elongate" to --include elongated--;

line 4, change "elongate" to --elongated--; line 11, change "comprise" to --include--; and

line 35, change "means" to --way--.

Page 8, line 11, change "semi-conductor" to --semiconductor--;

line 34, change "consist of" to --are in the form of --.

Page 9, line 5, change "means" to --mechanism--; and

lines 24 - 29, delete in its entirety; and

line 32, change "thanks" to --owing--.

Page 10, line 15, after "axial" insert --the--.

Page 11, line 17, change "comprises" to --includes--;

line 21, change "elongate" to --elongated--;

Page 12, line 5, change "means" to --way--;

lines 8-9, delete in its entirety;

line 10, insert --BRIEF DESCRIPTION OF THE DRAWINGS--;

line 16, change "," to --;--;

line 19, change "," to --;--;

line 22, change "," to --;--;

line 24, change "," to --;--;

line 27, change "," to --;--;

line 29, change "," to --;--;

line 31, change "," to --;--; and

line 34, change "," to --;--;

Page 13, line 2, change "," to --;--;

line 4, change "," to --;--;

line 7, change "," to --;--;

line 10, change "," to --;--;

line 13, change "," to --;--;

line 16, change "," to --;--;

line 19, change "," to --;--;

line 22, change "," to --; and --;

line 26, insert --DESCRIPTION OF THE PREFERRED EMBODIMENTS--;

line 27, delete "In" and insert --Referring now to the drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views, and more particularly to Figure 1, --;

line 29, change "The figure" to --Figure 1--;

line 31, change "towards" to --toward--; and

line 36, change "comprises" to --includes.

Page 14, line 9, after "form" insert --the--;

line 15, after "illustrated" insert --,--;

line 19, change "comprises" to --includes--; and

line 36, change "comprise" to --have--.

Page 15, line 2, change "9, 10, 11" to --51, 52 and 53--;

line 5, change "the figure consists" to --Figure 4 as formed as--;

line 6, delete "of";

line 24, change "3" to --4--;

line 28, change "4" to --5--; and

line 36, after "in" insert --the--.

Page 16, line 5, change "5" to --6--;

line 25, change "4" to --5--;

line 29, after "as" insert --a--;

line 30, after "as" insert --a--; and

line 34, change "first" to --third--.

Page 18, line 5, after "in" insert --the--;

line 23, after "in" insert --the--; and

line 28, after "with" insert --a--.

Page 19, line 3, change "this" to --the normal thickness--;

line 26, after "these" insert --free spaces--; and

line 32, change "6" to --11--.

Page 20, line 12, after "the" insert --same--; and

line 17, after "In" insert --the--.

Page 21, line 1, change "314" to --310--;

line 4, change "314" to --310--;

line 6, change "314" to --310--;

line 25, change "sealing" to --support; and

line 36, change "15" to --315--.

Page 22, line 30, change "comprises" to --includes--.

Page 23, line 19, after "inserted" insert --,--.

IN THE CLAIMS

Please cancel Claims 1-76 without prejudice or disclaimer.

Please add the following new Claims 77-153:

--77. A rotating electric machine comprising:

a stator having,

a slot, and

a winding drawn though said slot, said winding having an insulation system

with

a first semiconducting layer,

a solid insulation,

a second semiconducting layer, said solid insulation positioned

between said first semiconducting layer and said second semiconducting layer, and

a support member positioned in contact with said winding, wherein

said first semiconducting layer and said second semiconducting layer being

configured to provide respective equipotential surfaces.

78. The machine of Claim 77, wherein:

at least one of said first semiconducting layer and said semiconducting layer having a same coefficient of thermal expansion as the solid insulation.

79. The machine of Claim 77, wherein:

said winding including a cable configured to handle a high-voltage;

said slot having a cable lead-through portion of said cable disposed therein;

said support member being arranged in said slot in resilient fixation with the cable lead-through and configured to exert a pressure against said cable lead-through;

said support member being disposed between said cable lead-through and a side wall of the slot;

a spring material being positioned between the cable lead-through and the side wall of said slot; and

said support member and said spring material formed as an elongated pressure element running in a same direction as the cable lead-through.

80. The machine of Claim 79, further comprising:

a cable output configured to be directly connected to a power network without an intermediate transformer therebetween.

81. The machine of Claim 79, wherein:

said elongated pressure element being a tube having a sleeve containing a pressure-hardened material.

82. The machine of Claim 79, wherein:

said pressure-hardened material being an epoxy.

83. The machine of Claim 79, wherein:

said elongated pressure element including a tube having a sleeve containing a pressurized fluid.

84. The machine of Claim 79, further comprising:

additional elongated pressure elements, wherein

at least a majority of said elongated pressure element and said additional elongated pressure elements configured to exert pressure on said cable lead-through and an adjacent cable lead-through.

85. The machine of Claim 79, wherein:

an axial section of said slot having a profile with a varying cross-section in which, said side wall and an opposing side wall immediately opposite the cable lead-through each have,

a circular portion that corresponds to an outer diameter of the cable, and

a waist portion, being more narrow than said circular portion,

said elongated pressure element being disposed in said waist part.

86. The machine of Claim 85, wherein:

said axial section includes another waist part being a single-sided waist part defined on said side wall by a tangential plane to said circular portion and the opposing side wall and a connecting plane situated between and substantially parallel to a corresponding tangential plane and a plane connecting respective centers of the circular portion for the side wall and the opposing side wall,

said elongated pressure element being arranged at the side wall constituting the tangential plane.

87. The machine of Claim 79, wherein:

said elongated pressure element, and another elongated pressure element, being

arranged on a same side wall of the slot.

88. The machine of Claim 79, wherein:

said elongated pressure member and said spring material being arranged close to a same wall of said slot, said spring material being joined to the elongated pressure element.

89. The machine of Claim 79, wherein:

said elongated pressure element and said spring material being respectively positioned close to different walls of the slot.

90. The machine of Claim 89, wherein said spring member being of a sheet of elastic material.

91. The machine of Claim 90, wherein:

the sheet of elastic material includes slots formed therein.

92. The machine of Claim 88, wherein:

said spring material including a pad of elastic material applied on the support member.

93. The machine of Claim 92, wherein:

said pad has a slot formed therein.

94. The machine of Claim 77, wherein:

said winding further includes a cable configured to carry a high-voltage, and a corrugated sheet surrounding at least a portion of the cable lead-through in said slot.

95. The machine of Claim 94, wherein:

the corrugated sheet surrounds the cable continuously around an entire circumference of the cable and along an entire axial length of the cable in the slot.

96. The machine of Claim 94, wherein:

a largest diameter of the corrugated sheet being substantially equal to a width of the

slot; and

a depth of a corrugation in said corrugated sheet being sufficient to absorb a thermal expansion of the cable during operation of the machine.

97. The machine of Claim 94, wherein:

the corrugated sheet being formed from an elastically deformable material.

98. The machine of Claim 94, further comprising:

a casting compound disposed between the corrugated sheet and the slot.

99. The machine of Claim 94, wherein:

the corrugated sheet being formed from a separate tubular corrugated sheet applied around the second semiconducting layer, said second semiconducting layer being an outer semiconducting layer of the cable.

100. The machine of Claim 99, wherein:

corrugations formed on the corrugated sheet being annular corrugations.

101. The machine of Claim 94, wherein:

a surface of said corrugated sheet having corrugations formed in the second semiconducting layer of the winding, said second semiconducting layer being an outer semiconducting layer.

102. The machine of Claim 101, wherein:

the corrugations in the second semiconducting layer being oriented in a longitudinal direction of the winding.

103. The machine of Claim 77, wherein:

the winding includes a cable configured to carry a high-voltage; and

said support member includes an elongated elastic support element arranged along and in contact with a cable lead-through of said cable disposed in said slot.

104. The machine of Claim 103, wherein:
the support member being shaped to extend along an entire axial extension of the stator.
105. The machine of Claim 103, wherein:
the support member being a hose.
106. The machine of Claim 105, wherein:
the hose encloses a pressure medium.
107. The machine of Claim 106, wherein:
the pressure medium being a fluid.
108. The machine of Claim 107, wherein:
the hose being sealed at both ends thereof.
109. The machine of Claim 107, wherein:
the fluid of the pressure medium being configured to communicate with a pressure source.
110. The machine of Claim 106, wherein:
the pressure medium being an elastic material in a solid form.
111. The machine of Claim 110, wherein:
the elastic material having a cavity running axially therethrough.
112. The machine of Claim 111, wherein:
the cavity having a non-circular cross-section.
113. The machine of Claim 103, wherein:
said slot in a radial plane having a profile with respective wide parts and narrow parts alternating in a radial direction.
114. The machine of Claim 113, wherein:

the narrow parts being asymmetrically positioned in relation to a central plane running radially through the slot.

115. The machine of Claim 114, wherein:

respective of the narrow parts being mirror-inverted in relation to a nearest adjacent narrow part of the respective narrow parts when viewed in a direction of the radial plane.

116. The machine of Claim 103, wherein:

said support element abuts the cable lead-through and an adjacent cable lead-through of the winding.

117. A rotating electric machine comprising:

a high-voltage magnetic circuit having,

a magnetic core, and

a winding of a cable, said cable having,

a conductor configured to carry electrical current and having respective strands,

an inner semiconducting layer disposed around said conductor,

a solid insulation disposed around said inner semiconducting layer, and

an outer semiconducting layer disposed around said solid insulation;

and

a support member positioned along and in contact with said winding.

118. The machine according to Claim 117, wherein:

said magnetic core includes a slot in which said cable of said winding is disposed;

said inner semiconducting layer and said outer semiconducting layer being configured to provide respective equipotential surfaces.

119. A method for manufacturing a rotating electric machine, comprising the steps

of:

forming a winding for a stator by positioning a cable in a slot of the stator, said cable being configured to hold a high-voltage and having a first semiconducting layer, a solid insulation, and a second semiconducting layer, said solid insulation positioned between said first semiconducting layer and said second semiconducting layer, said first semiconducting layer and said second semiconducting layer providing respective equipotential surfaces; and

inserting an elongated support member axially in said slot and in contact with said cable.

120. The method of Claim 119, wherein:

said inserting step, comprises

inserting hose-like element as said elongated support element in the slot, and filling the hose-like element with a pressure medium.

121. The method of Claim 120, wherein:

said filling step comprises

filling the hose-like element with a curable material; and hardening the curable material under pressure.

122. The method of Claim 120, wherein:

said filling step comprises filling said hose-like element with epoxy.

123. The method of Claim 120, wherein:

said inserting step comprises inserting said hose-like element after said cable has been inserted in said slot.

124. The method of Claim 120, wherein:

said inserting step comprises inserting said hose-like element in said slot, and in at least another slot in a to-and-fro pattern.

125. The method of Claim 119, further comprising:

surrounding the cable with a corrugated sheath before inserting the cable into the slot.

126. The method of Claim 125, wherein said surrounding step comprises applying a separate tubular corrugated sheet around the cable before inserting the cable into the slot.

127. The method of Claim 125, wherein:

said surrounding step comprises surrounding the corrugated sheath by applying a separate tubular corrugated sheath in the slot before inserting the cable into the slot.

128. The method of Claim 126 wherein:

said surrounding step comprises applying a lubricant on the cable in an axial direction.

129. The method of Claim 125, further comprising the step of:

inserting a casting compound between the corrugated sheath and a wall of the slot.

130. The method of Claim 129, further comprising the step of:

casting axial cooling tubes in the casting compound.

131. The method of Claim 125, wherein:

said surrounding step comprises surrounding the cable with the corrugated sheath which includes annular corrugations.

132. The method of Claim 125, wherein:

said step of surrounding comprises surrounding the cable with the corrugated sheath having annular corrugations that run in a helical direction.

133. The method of Claim 125, wherein:

said surrounding step comprises surrounding the cable with the second semiconducting layer as an outer semiconducting layer having corrugations as said corrugated sheath surface.

134. The method of Claim 133, wherein:

said surrounding step, comprises surrounding the cable with the corrugations running in a longitudinal direction.

135. The method of Claim 133, further comprising the step of:

extruding the outer semiconducting layer of the cable.

136. The method of Claim 119, wherein:

said inserting step comprises inserting said support element in an axial direction after winding the cable.

137. The method of Claim 136, wherein:

said inserting step comprises inserting the support element into a space between a cable lead-through of said cable and a wall of said slot while having said support element maintain a state that enables said support element to pass through a profile of said slot without obstruction or resistance in an axial cross-section of said slot; and

expanding transversely said support element in an axial direction after said inserting step.

138. The method of Claim 137, wherein:

said inserting step, comprises inserting a thin walled elastic hose as said support element, and while said thin walled elastic hose is decompressed such that a thinness and elasticity of said thin walled elastic hose is sufficient so as to be deformed without noticeable resistance for allowing passage of the thin walled elastic hose through the space.

139. The method of Claim 137, wherein:

said inserting step comprises inserting the support element when surrounding an elongated body along an entire length of the thin walled elastic hose such that a cross-sectional dimension of said body and said hose, having a void space formed therebetween,

and filling said void space with a hardening elastic material after said support element is inserted into the slot and expanding the hose transversely to the axial direction.

140. The method of Claim 139, wherein:

said filling step comprises filling the elongated body, which includes an inner, thin-walled hose, with a pressure medium before said void space is filled.

141. The method of Claim 140 further comprising:

removing the elongated body from the void space after the void space is filled and said pressure medium hardened, said elongated body being a rod element.

142. The method of Claim 141, wherein the rod element having a profile with longitudinal ridges thereon.

143. The method of Claim 137, wherein said support element having a cross-sectional profile a sufficient clearance for being inserted into said space, and allowing a passage into said space.

144. The method of Claim 119, wherein:

said inserting step includes subjecting the support element to an axial tensile force to reduce a cross-sectional profile of the support element and allow passage of said support element into said space; and

releasing the tensile force when the support element is in position so as to expand the cross-sectional profile of the support element.

145. The method of Claim 136 wherein:

said inserting step includes forcibly deforming the support element, said support element being a hose, and

releasing the hose from the deformed state after inserting the hose into the space.

146. The method of Claim 145, wherein:

said forcibly deforming step includes gluing the hose so as to assume a forcibly deformed state; and

releasing an adhesive joint made during said gluing step when the hose is in place.

147. The method of Claim 145, wherein:

said inserting step includes subjecting an interior of the hose to a negative pressure, and

releasing the negative pressure when the hose is in place.

148. The method of Claim 137, wherein:

said inserting step includes inserting the support element as a hose having a cross-sectional profile, said cross-sectional profile being less than a cross-sectional profile of said space; and

filling the hose with a pressure medium when the hose is in place.

149. The method of Claim 148, wherein:

said filling step comprises filling the hose with a cold-setting material as said pressure material.

150. The method of Claim 148, wherein:

said filling step comprises filling said hose with at least one of a gas and a liquid; and sealing the hose at respective ends thereof after said hose is filled with the pressure medium.

151. The method of Claim 148, wherein:

said filling step comprises filling the hose with at least one of a gas and a liquid while maintaining communication between the pressure medium and a pressure source even while the rotating machine is in operation.

152. The method of Claim 148, wherein;

said filling step comprises expanding the hose with a rod-shaped body as said pressure medium so as to expand said hose.

153. A rotating electric machine comprising:

a stator having a slot;

a high-voltage winding disposed in said slot, having

means for conducting an electrical current in said high-voltage winding,

means for electrically insulating said means for conducting, said means for electrically insulating having,

means for creating a first equipotential surface around said means for conducting,

means for creating a second equipotential surface around said means for creating the first equipotential surface, and

means for separating said first equipotential surface from said second equipotential surface; and

means for supporting said winding in said slot.--

IN THE ABSTRACT OF THE DISCLOSURE

After page 33, please add the following abstract:

--A rotating electrical machine and method for making the machine, where the machine includes a high-voltage stator winding and elongated support devices for supporting the winding. The machine and method employ an arrangement of cable that is made of inner conductive strands, covered with a first semiconducting layer, which is covered with an insulating layer, which is covered with a second semiconducting layer. The cable is wound in slots in the stator such that separate cable lead-throughs are positioned in specific

arrangements with respect to each other and in slots of the stator. The arrangement of the cable in the stator protects the integrity of the respective components in the cable and particularly the second semiconducting layer.--

REMARKS

Favorable consideration of this application as presently amended and in light of the following discussion is respectfully requested.

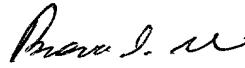
Claims 77-153 are pending, Claims 1-76 having been canceled without prejudice or disclaimer and Claims 77-153 having been added by way of the present amendment. New Claims 77-153 find support in original Claims 1-76 and in the specification as originally filed, and consequently no new matter is added.

While numerous amendments have been made to the specification, consistent with accepted U.S. patent application drafting format, each amendment is believed to be made as a matter of form. However, to the extent any amendment is substantively inconsistent with the originally filed specification, the language included in the originally filed specification should be construed as containing the controlling language. Due to the large number of changes, and for the examiner's convenience, a "clean copy" of the specification is filed herewith that includes all of the amendments made by way of the present preliminary amendment.

Consequently, in view of the present amendment, an action on the merits is earnestly solicited.

Respectfully submitted,

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ROTATING ELECTRICAL MACHINE COMPRISING HIGH-VOLTAGE STATOR WINDING AND
ELONGATED SUPPORT DEVICES SUPPORTING THE WINDING AND METHOD FOR MANU-
FACTURING SUCH MACHINE

5 The present invention relates in a first aspect to a rotating electric machine of the type described in the preamble to claim 1 or claim 41, e.g. synchronous machines, normal synchronous machines as well as dual-fed machines, applications in asynchronous static current converter cascades, outerpole machines and synchronous flow machines.

10 A second aspect of the invention relates to a method of the type described in the preamble to claim 43.

15 In the present application the terms radial, axial and peripheral constitute indications of direction defined in relation to the stator of the machine unless expressly stated otherwise. The term cable lead-through refers in the application to each individual length of the cable extending through a slot.

20 The machine is intended primarily as a generator in a power station for generating electric power. The machine is intended for use with high voltages. High voltages shall be understood here to mean electric voltages in excess of 10 kV. A typical operating range for the machine according to the invention may be 36 to 800 kV.

25 Similar machines have conventionally been designed for voltages in the range 6-30 kV and 30 kV has normally been considered to be an upper limit. This generally implies that a generator is to be connected to the power network via a transformer which steps up the voltage to the level of the power network, i.e. in the range of approximately 100-400 kV.

30 By using high-voltage insulated electric conductors, in the following termed cables, with solid insulation similar to that used in cables for transmitting electric power in the stator winding (e.g. PEX cables) the voltage of the machine may be increased to such levels that it be connected directly to the power network without an intermediate transformer. PEX = Cross-linked polyethylene (XLPE).

35

This concept generally implies that the slots in which the cables are placed in the stator to be deeper than conventional technology (thicker insulation due to higher voltage and more turns in the winding) requires. This entails new problems with regard to cooling, vibrations and natural frequencies in the region of the coil end, teeth and winding.

Securing the cable in the slot is also a problem - the cable is to be inserted into the slot without its outer layer being damaged. The cable is subjected to currents having a frequency of 100 Hz which cause a tendency to vibration and, besides manufacturing tolerances with regard to the outer diameter, its dimensions will also vary with variations in temperature (i.e. load variations).

Although the predominant technology when supplying current to a high-voltage network for transmission, subtransmission and distribution, involves inserting a transformer between the generator and the power network as mentioned in the introduction, it is known that attempts are being made to eliminate the transformer by generating the voltage directly at the level of the network. Such a generator is described in US-4 429 244, US-4 164 672 and US-3 743 867.

The manufacture of coils for rotating machines is considered possible with good results up to a voltage range of 10-20 kV.

Attempts at developing a generator for voltages higher than this have been in progress for some time, as is evident from "Electrical World", October 15 1932, pages 524-525, for instance. This describes how a generator designed by Parson 1929 was constructed for 33 kV. A generator in Langerbrugge, Belgium, is also described which produced a voltage of 36 kV. Although the article also speculates on the possibility of increasing the voltage levels, development of the concepts upon which these generators were based ceased. This was primarily due to deficiencies in the insulating system where several layers of varnish-impregnated mica foil and paper were used.

Certain attempts at lateral thinking in the design of synchronous generators are described in an article entitled "Water-and-oil-cooled Turbogenerator TVM-300" in J. Elektrotechnika, No. 1 1970, pages 6-8 of US 4,429,244 "Stator of generator" and in Russian patent specification CCCP Patent 955369.

The water-and-oil-cooled synchronous machine described in J. Elektrotechnika is intended for voltages up to 20 kV. The article describes a new insulation system consisting of oil/paper insulation whereby it is possible to immerse the stator completely in oil. The oil can then be used as coolant and simultaneously insulation. A dielectric oil-separating ring is provided at the internal surface of the core to prevent oil in the stator from leaking out towards the rotor. The stator winding is manufactured from conductors having oval, hollow shape, provided with oil and paper insulation. The coil sides with the insulation are retained in the slots with rectangular cross section by means of wedges. Oil is used as coolant both in the hollow conductors and in cavities in the stator walls. However, such cooling systems necessitate a large number of connections for both oil and electricity at the coil ends. The thick insulation also results in increased radius of curvature of the conductors which in turn causes increased size at of the coil overhang.

The above-mentioned US patent relates to the stator part of a synchronous machine comprising a magnetic core of laminated plate with trapezoid slots for the stator winding. The slots are stepped since the need for insulation of the stator winding decreases less in towards the rotor where the part of the winding located closest to the neutral point is situated. The stator part also includes dielectric oil-separating cylinders nearest the inner surface of the core. This part will increase the excitation requirement in comparison with a machine lacking this ring. The stator winding is manufactured from oil-saturated cables having the same diameter for each layer of the coil. The layers are separated from each other by means of spacers in the slots and secured with wedges. Characteristic of the winding is that it consists of two "half-windings" connected in series. One of the two half-windings is situated centrally inside an insulating sheath. The conductors of the stator winding are cooled by surrounding oil. A drawback with so much oil in the system is the risk of leakage and the extensive cleaning-up process required in the event of a fault condition. The parts of the insulating sheath located outside the slots have a cylindrical part and a conical screening electrode whose task it is to control the electrical field strength in the area where the cable leaves the plate.

It is evident from CCCP 955369 that in another attempt at increasing the rated voltage of a synchronous machine, the oil-cooled stator winding consists of a

conductor with insulation for medium-high voltage, having the same dimension for all layers. The conductor is placed in stator slots in the shape of circular, radially situated openings corresponding to the cross-sectional area of the conductor and space required for fixation and cooling. The various radially located layers of the winding are surrounded and fixed in insulating tubes. Insulating spacer elements fix the tubes in the stator slot. In view of the oil cooling, an inner dielectric ring is also required here to seal the oil coolant from the inner air gap. The construction illustrated has no stepping of the insulation or of the stator slots. The construction shows an extremely narrow, radial waist between the various stator slots, entailing a large slot leakage flow which greatly affects the excitation requirements of the machine.

A report from the Electric Power Research Institute, EPRI, EL-3391, from April 1984 an exposition is given of the generator concept in which a to higher voltage is achieved in an electric generator with the object of being able to connect such a generator to a power network without intermediate transformers. The report deems such a solution to offer satisfactory gains in efficiency and financial advantages. The main reason that in 1984 it was considered possible to start developing generators for direct connection to the power network was that by that time a superconducting rotor had been developed. The considerable excitation capacity of the superconducting field makes it possible to use air-gap windings with sufficient thickness to withstand the electric stresses.

By combining the construction of an excitation circuit, the most promising concept of the project, together with winding, a so-called "monolithic cylinder armature", a concept in which two cylinders of conductors are enclosed in three cylinders of insulation and the whole structure is attached to an iron core without teeth, it was deemed that a rotating electric machine for high voltage could be directly connected to a power network. This solution implied that the main insulation had to be made sufficiently thick to withstand network-to-network and network-to-earth potentials. Besides it requiring a superconducting rotor, an obvious drawback with the proposed solution is that it requires a very thick insulation, thus increasing the size of the machine. The coil ends must be insulated and cooled with oil or freones in order to direct the large electric fields in the ends. The whole machine is to be hermetically enclosed to prevent the liquid dielectric medium from absorbing moisture from the atmosphere.

It is also known, e.g. through FR 2 556 146, GB 1 135 242 and US 3 392 779, to apply various types of support members for the windings in the slots of a rotating electric machine. These do not apply to machines having an insulation system designed specifically for high voltages, and therefore lack relevance for the present invention.

The present invention is related to the above-mentioned problems associated with avoiding damage to the surface of the cable caused by wear against the surface, resulting from vibration during operation.

The slot through which the cable is inserted is relatively uneven or rough since in practice it is extremely difficult to control the position of the plates sufficiently exactly to obtain a perfectly uniform surface. The rough surface has sharp edges which may shave off parts of the semiconductor layer surrounding the cable. This leads to corona and break-through at operating voltage.

When the cable is placed in the slot and adequately clamped there is no risk of damage during operation. Adequate clamping implies that forces exerted (primarily radially acting current forces with double mains frequency) do not cause vibrations that cause wear on the semiconductor surface. The outer semiconductor is to thus be protected against mechanical damage even during operation.

During operation the cable is also subjected to thermal loading so that the cross-linked polyethylene material expands. The diameter of a 145 kV cross-linked polyethylene cable, for instance, increases by about 1.5 mm at an increase in temperature from 20 to 70°C. Space must therefore be allowed for this thermal expansion.

It is already known to arrange a tube filled with cured epoxy compound between the bundle of cables in a slot and a wedge arranged at the opening of the slot in order to compress the cables in radial direction out towards the bottom of the slot. The abutment of the cables against each other thus also provides certain fixation in lateral direction. However, such a solution is not possible when the cables are arranged separated from each other in the slot. Furthermore the positioning force in lateral direction is relatively limited and no adjustment to variations in diameter

is achieved. This construction cannot therefore be used for high-voltage cables of the type under consideration for the machine according to the present invention.

5 Against this background the object of the present invention is to solve the problems of achieving a machine of the type under consideration so that the cable is not subjected to mechanical damage during operation as a result of vibrations, and which permits thermal expansion of the cable. Achieving this would enable the use of cables that do not have a mechanically protecting outer layer. In such a case the outer layer of the cable consists of a thin semiconductor material which is
10 sensitive to mechanical damage.

According to a first aspect of the invention this has been solved by giving a machine of the type described in the preamble to claim 1 or claim 41 the special features defined in the characterizing part of respective claims.
15

The invention is in the first place intended for use with a high-voltage cable composed of an inner core having a plurality of strand parts, an inner semi-conducting layer, an insulating layer situated outside this and an outer semi-conducting layer situated outside the latter, particularly in the order of magnitude
20 of 20 -200 mm in diameter and 40-3000 mm² in conducting area.

The application on such cables thus constitutes preferred embodiments of the invention.

25 The elongate pressure members running parallel with the cable lead-throughs secure the latter in the slots and their elasticity permits a certain degree of fluctuation in the diameter of the cable to be absorbed. An important prerequisite is hereby created for achieving a machine with high-voltage cables in the windings at a voltage level that permits direct connection to the power network
30 without any intermediate transformer.

According to a particularly advantageous embodiment of the invention at least one of the two semi-conducting layers has the same coefficient of thermal expansion as the solid insulation so that defects, cracks and the like are avoided upon thermal
35 movement in the winding.

According to a preferred embodiment of the invention the support members comprise elongate pressure members.

5 The elongate pressure members running parallel with the cable parts secure the latter in the slots and the resilient members allow for the absorption of a certain degree of fluctuation in the diameter of the cable. An important prerequisite is hereby created for achieving a machine with high-voltage cables in the windings at a voltage level that permits direct connection to the power supply system without any intermediate transformer.

10

In an advantageous embodiment of the invention the pressure elements comprise a tube filled with a pressure-hardened material, preferably epoxy. An expedient and reliable type of pressure element is hereby obtained, which is simple to apply.

15 According to a preferred embodiment each pressure element is arranged to act simultaneously against two cable lead-throughs so that the number of pressure elements may be limited to approximately half the number of cable lead-throughs in each slot. The pressure elements are preferably arranged in waist parts of the slot, situated between a pair of cable lead-throughs, thus facilitating the use of a
20 single pressure element for two cable lead-throughs. In this case it is advantageous to design the waist part with a constriction on only one side so as to leave space for the pressure element on the opposite side.

According to a preferred embodiment the pressure members are arranged on the
25 same side of the slot as the resilient members, which produces a simple embodiment. It is also advantageous for the pressure members and resilient members to be joined together, suitably as a pressure hose with resilient pads applied on its outer surface.

30 According to yet another preferred embodiment the support member consists of a corrugated sheath surrounding the cable.

Since the cable is surrounded by a corrugated sheath it will be firmly fixed in the stator slots, the tops of the corrugations abutting and supported by the slot walls.
35 The vibrations are suppressed by means of clamping at the same time as the outer semi-conductor layer of the cable is protected from damaging contact with the

laminations in the slot walls. The corrugations also allow space for thermal expansion of the cable.

5 In a preferred embodiment of the invention the corrugated sheath is in the form of a separate tubular corrugated sheath applied around the outer semiconductor layer of the cable. The tube may be made of insulating or electrically conducting plastic. The sheath thus constitutes a protection that screens the semiconductor layer from direct contact with the slot walls, thereby protecting it. The sheath is thus in contact with the depressions of the corrugations towards the semi-
10 conductor layer and the cable can expand in the undulating spaces formed between sheath and semi-conductor layer.

In this preferred embodiment it is also advantageous to arrange the corrugations annularly or as a helix. It is also advantageous in this embodiment to arrange a
15 casting compound between sheath and slot walls. The position of the sheath is thus fixed more securely, avoiding any risk of it being displaced. Favourable heat transfer is also obtained from the cable to surrounding parts and any cooling arrangements provided. These may advantageously be embedded in the casting compound as longitudinally running tubes.

20 In a preferred alternative embodiment of the invention the corrugated sheath surface is in the form of corrugations directly in the outer semiconductor layer of the cable. The semiconductor layer will then admittedly come into direct contact with the slot walls, but only at the tops of the corrugations. Since the outer
25 semiconductor layer is limited on its inner side by a cylindrical surface, its thickness at the tops of the corrugations will be considerable so that any damage to the tops of the corrugations on the semiconductor layer as a result of scratching or wear from the slot walls will not cause significant damage to the semiconductor layer.

30 In this alternative embodiment the corrugations preferably run in the longitudinal direction of the cable.

35 In another advantageous embodiment the pressure elements consist of a hose. An expedient and reliable type of support element is thus formed, which is also simple to apply.

According to a preferred variant of this embodiment, the hose is filled with a pressure fluid. This enables the elasticity and contact pressure to be easily adjusted to that required. The hose may either be closed, which has the advantage
5 that no special means is required to maintain the pressure, or the pressure medium in the hose may communicate with a pressure source, enabling the pressure to be regulated and reduced if necessary.

In another preferred embodiment the hose encloses a pressure medium in solid
10 form, e.g. silicon rubber, an alternative that provides ease of manufacture, little risk of faults occurring and requires little maintenance. In this case, the pressure medium should preferably have a cavity running axially through it.

According to a preferred embodiment each support element is arranged to act
15 simultaneously against two cable parts so that the number of support elements may be limited to approximately half the number of cable lead-throughs in each slot. The support elements are preferably arranged in waist parts of the slot, situated between a pair of cable lead-throughs, thus facilitating the use of a single
20 support element for two cable lead-throughs. In this case it is advantageous to design the waist parts with a larger constriction on only one side so as to leave space for the support element on the opposite side, which may have a shallower constriction or none at all, i.e. so that the narrow part is asymmetrical.

The above and other advantageous embodiments of the machine according to the
25 invention are defined in the sub-claims to claim 1 and claim 41.

From a second aspect the objective has been achieved by giving a method as described in the preamble to claim 43 the special features defined in the
30 characterizing part of this claim.

According to a preferred embodiment of the method according to the invention, pressure members can be conveniently arranged in the stator slots so that, thanks to the hose being filled with pressure medium after it is in place, an economic
35 manufacturing process is achieved with regard to this particular component of the machine.

It is advantageous to pull the hose through several times, forwards and backwards, thereby producing several pressure elements from the same hose which is jointly filled with pressure medium.

- 5 According to another preferred embodiment the cable is surrounded by a corrugated sheath before it is inserted into the slot.

This embodiment offers considerable advantages since the risk of the laminations shaving off vital parts of the outer semiconductor layer is eliminated since only the
10 tops of the corrugations reach the slot walls.

In a preferred embodiment of the alternative just described, a separate, tubular corrugated sheath is applied around the cable before it is inserted into the slot.

- 15 In this embodiment the sheath is preferably fitted over the cable in axial direction and a lubricant is used, thereby achieving simple application of the sheath onto the cable.

In an advantageous variant of this embodiment of the method the corrugations on the sheath are annular. When the sheath with the cable is inserted into the slot by pulling on the sheath, the annular corrugations cause the sheath to stretch in longitudinal direction at the same time as its largest diameter decreases, i.e. the
20 tops of the corrugations move radially inwards. A clearance is thus obtained between the sheath and the slot wall which facilitates insertion. When the sheath
25 is in place and tensile force is no longer applied, it returns to its original shape where the tops of the corrugations will be in contact with the slot wall and fix the cable firmly in place.

In an alternative embodiment of the method the corrugations run in the longitudinal direction of the cable. In a particularly preferred embodiment of this
30 alternative the corrugations are produced directly in the outer semiconductor layer of the cable. The advantage is thus achieved that the need for a separate element is eliminated. It also means that the corrugations can be produced simply by manufacturing the cable in such a way that its outer semiconductor layer is
35 extruded, which constitutes a preferred embodiment of this alternative.

The support element is preferably inserted axially, after the winding phase.

Since the support elements are inserted after the high-voltage cable has been wound they constitute no obstruction for passing the cable through the slot during the actual winding process, and the axial insertion can be carried out in a simple manner, several advantageous ways being feasible.

In a preferred embodiment of the method each support element is inserted in such a state that it can pass without obstruction through the cross-sectional profile formed in the available space between cable and slot wall. Once the support element is in place it is caused to expand transversely to the axial direction.

Since the support element is given its intended thicker extension only after insertion, enabling it to be inserted without obstruction, there is negligible friction during the insertion, which facilitates the process.

In a preferred variant of this invention the support element comprises an outer, thin-walled elastic hose. If it is sufficiently thin and elastic it will be so slippery that it can easily be inserted as described above. The hose can then be filled with cold-hardening silicon rubber to assume its expanded state, in which case the hose should suitably contain an elongate body upon insertion. When the hose is thereafter filled with the hardening, elastic material, the space between body and hose will be filled and less filler is required.

Another preferred variant to achieve unimpeded insertion of the support element is for it to have a smaller cross-sectional profile than the cross-sectional profile of the available space so that there is a clearance upon insertion. It may be advantageous to subject the support element to an axial tensile force upon insertion so that its cross-sectional profile is reduced. Once in place, the tensile force is released so that the support element assumes its operating shape. This offers a simple method of application. Alternatively the cross-sectional profile of the support element may be forcibly deformed so that it can be passed through the space, whereupon the deformation is released when the element is in place. This also constitutes a simple and expedient method of application.

A third preferred variant for achieving unimpeded insertion is for the support element originally to have had a cross-sectional profile in unloaded state that is less than the cross-sectional profile of the space, and is in the form of a hose which, when it has been applied, is expanded by placing the hose under pressure, suitably by means of pressurized gas or liquid or by introducing a cold-hardening compound which is allowed to solidify.

The above and other advantageous embodiments of the method according to the invention are defined in the sub-claims to claim 43.

10

The invention will be explained in more detail in the following description of advantageous embodiments, with reference to the accompanying drawings in which;

15 Figure 1 shows schematically an axial end view of a sector of the stator in a machine according to the invention,

Figure 2 shows a cross-section through a cable used in the machine according to the invention,

20

Figure 3 shows schematically an axial partial section through a stator slot according to a first embodiment of the invention,

Figures 4 is a section along the line III-III in Figure 3,

25

Figure 5 is a section corresponding to that in Figure 3, but illustrating a second embodiment of the invention,

Figure 6 shows a detail of Figure 3 prior to assembly,

30

Figure 7 shows in equivalent manner to Figure 6, a detail from Figure 5,

Figure 8 shows a view in perspective of a cable with sheath according to a third embodiment of the invention,

35

Figure 9 shows a radial partial section through a slot in a stator in the embodiment according to Figure 8,

Figure 10 is a section along the line V-V in Figure 9,

Figure 11 is a view in perspective of a cable according to a fourth embodiment of the invention,

Figure 12 is a radial partial section of a slot according to a fifth embodiment of the invention,

Figures 13 - 15 are sections corresponding to Figure 12 according to alternative embodiments of the invention,

Figure 16 is a view in perspective of a support element according to one embodiment of the invention,

Figures 17 and 18 are sections corresponding to Figure 12 illustrating additional alternative embodiments of the invention,

Figures 19 - 21 show cross-sections through the support element according to additional alternative embodiments of the invention,

Figure 22 is a section corresponding to Figure 12 illustrating yet another embodiment of the invention.

In the axial view shown schematically in Figure 1 through a sector of the stator 1 of the machine, its rotor is designated 2. The stator is composed in conventional manner of a laminated core of sheet steel. The figure shows a sector of the machine, corresponding to one pole division. From a yoke portion 3 of the core situated radially outermost, a number of teeth 4 extend radially in towards the rotor 2 and are separated by slots 5 in which the stator winding is arranged. The cables 6 in the windings are high-voltage cables which may be of substantially the same type as high-voltage cables used for power distribution, so-called PEX cables. One difference is that the outer mechanically protective sheath that normally surrounds such a cable has been eliminated. The cable thus comprises

only the conductor, an inner semiconductor layer, an insulating layer and an outer semiconducting layer. The semiconductor layer, sensitive to mechanical damage, is thus exposed on the surface of the cable.

- 5 In the drawings the cables 6 are illustrated schematically, only the conducting central part of the cable lead-through or coil side being drawn in. As can be seen, each slot 5 has varying cross-section with alternating wide parts 7 and narrow parts 8. The wide parts 7 are substantially circular and surround cable lead-throughs, and the waist parts between these form narrow parts 8. The waist parts
10 serve to radially position each cable lead-through. The cross-section of the slot as a whole also becomes slightly narrower in radial direction inwards. This is because the voltage in the cable lead-throughs is lower the closer they are situated to the radially inner part of the stator. Slimmer cable lead-throughs can therefore be used here, whereas increasingly coarser cable lead-throughs are required further
15 out. In the example illustrated cables of three different dimensions are used, arranged in three correspondingly dimensioned sections 51, 52, 53 of the slots 5.

- Figure 2 shows a cross-sectional view of a high-voltage cable 6 according to the present invention. The high-voltage cable 6 comprises a number of strand parts 31
20 made of copper (Cu), for instance, and having circular cross section. These strand parts 31 are arranged in the middle of the high-voltage cable 6. Around the strand parts 31 is a first semiconducting layer 32. Around the first semiconducting layer 32 is an insulating layer 33, e.g. cross-linked polyethylene insulation. Around the insulating layer 33 is a second semiconducting layer 34. The concept "high-voltage cable" in the present application thus need not include the metal screen
25 and the outer protective sheath that normally surround such a cable for power distribution.

- Figure 3 shows an enlarged section through a part of a stator slot 5. The slot is of
30 substantially the type shown in Figure 1. One difference is that some of the waist parts 8, i.e. the narrower parts that separate the cable lead-throughs 6, are one-sided. Thus alternate narrower parts 8b have constrictions on both sides so that the narrow part is substantially symmetrical, and alternate narrower parts 8a have a constriction on only one side, the other side lying in the tangential plane 9 to adjacent arc-shaped wide parts. In longitudinal direction, therefore, the slot 5 will
35 comprise parts having three different widths; the wide circular parts 7, the single-

sided waist parts 8a and the even narrower double-sided waist parts 8b. As in Figure 1, the slot 5 is also composed of sections 9, 10, 11 of different widths.

The arrangement of the single-sided waist parts 8a provides extra space in the slot
5 for pressure elements 13. The pressure element 13 illustrated in the figure consists of a hose extending axially through the slot, i.e. parallel with the cable lead-throughs 6. The pressure element 13 is filled with pressure-hardened epoxy which presses the hose out towards adjacent surfaces, acquiring a shape conforming to these surfaces upon hardening. The epoxy is introduced at a pressure of
10 approximately 1 MPa. The hose thus acquires a substantially triangular cross-section, with a first surface 11a supported by the slot wall, a second concave arc-shaped surface 11b abutting one of the adjacent cable lead-throughs 6b and a third surface 11c having the same shape as the second but abutting another of the adjacent cable lead-throughs 6a. Arranged in this manner, the pressure element 13
15 simultaneously presses the two cable lead-throughs 6a and 6b against the opposite slot wall with a force on each cable lead-through 6a, 6b that is directed substantially towards its centre.

A sheet 14 of rubber or other material having equivalent elastic properties is
20 arranged on the opposite slot wall. Each cable lead-through will thus be resiliently clamped between the pressure element 13 and the rubber sheet 14 so that it is fixed in its position but so that thermal expansion of the cable can also be accommodated. As can be seen in the enlarged section through it shown in Figure 3, the rubber sheet 14 is suitably provided with slots 15 enabling optimal
25 adjustment of the spring constant in the sheet by a suitable selection of depth, breadth and pitch thereof.

Figure 4 shows an alternative embodiment of the invention, modified from that according to Figure 2 substantially in that the rubber sheet 14 has been replaced
30 with rubber pads 16b, 16c, arranged in the form of flat rubber strips along the surfaces 111b, 111c of the pressure element 113 facing the cable lead-throughs. These rubber pads provide the necessary elasticity in the positioning and eliminate the need for a rubber sheet on the opposite side. Another difference is that a longitudinal recess 17 is provided in axial direction in the wall of the slot 5 at the
35 points where the pressure elements 113 are arranged. This affords more space for the pressure elements 113 and also supports them in radial direction.

The pressure elements 13, 113 are inserted into the slots after the stator cables have been wound. The hose 11, 111 for the pressure elements 13, 113 is then inserted axially into the substantially triangular space between a pair of cable lead-throughs and the tangential wall part 9. At this stage the hose is not yet filled with epoxy and therefore has a collapsed shape as illustrated in Figures 5 and 7 for respective embodiments. It is thus easy to pull the hose through the available space. When the hose is in place it is filled with epoxy so that its cross section expands and substantially fills the triangular gap. Epoxy is introduced under sufficient pressure to press respective cable lead-throughs 6a, 6b with the desired force against the opposite wall of the slot. The pressurized epoxy is allowed to harden at this pressure to maintain a constant pressure on the cable lead-throughs.

A single hose 11, 111 can be pulled repeatedly forwards and backwards through the slot 5 so that the various pressure elements forming the pressure members of a slot are formed out of a single long hose upon application, the hose then being filled with epoxy as described above. When the epoxy has hardened properly, the arc-shaped hose parts formed outside each end plane of the stator can be cut away and removed.

The rubber sheet in the example shown need not necessarily be arranged in the part of the slot opposite to the pressure element. Instead it may be arranged on the same side. Neither need the resilient element in the embodiment according to Figure 2 be in the form of a sheet, but may in the form of a strip as in the embodiment according to Figure 4.

Instead of using a material such as epoxy which is hardened under pressure, the hose may be filled with a pressure fluid in gaseous or liquid form. In this case the tube itself acquires elastic properties and will function both as pressure element and as resilient member. The rubber sheet/strips are not needed in such an embodiment.

Figure 8 shows a perspective view of the cable 6 surrounded by a sheath 212 according to a first embodiment of the invention. The sheath 212 has annular ridges with tops 213 and annular depressions 214 between the tops.

Figure 9 shows a part of a stator slot in a radial section through the embodiment according to Figure 8. In the embodiment illustrated the slot does not have the shape of a bicycle chain as shown in Figure 1 but instead has slot walls that are substantially flat in radial direction. Each cable part 6 is surrounded by a sheath 212 of the type shown in Figure 8. The section is taken through one of the annular corrugation tops 213, i.e. when the sheath extends out to the slot wall. The annular depression 214 behind is in contact with the cable 6. The space between the cables 6 is filled with a casting compound 215. This also fills out the space between the ridges, as is symbolized by the dotted area in the figure. The sheath 212 is a plastic tube of insulated or electrically conducting plastic, and the casting compound is a suitable casting resin, epoxy. Cooling tubes 216 may be arranged in the casting compound in the triangular spaces formed between the cables. The cooling tubes may be of stainless steel or plastic, e.g. HD-PEX.

15 The difference between the outer and inner diameter of the corrugated sheath 212 is suited to the thermal expansion of the cable, normally about 3-4 mm. The wave depth, i.e. the distance between a depression 214 and a top 213 (d in Figure 5) is thus about 1.5-2 mm.

20 The cable 6 with sheath is shown in an axial section in Figure 10, the upper half of the figure illustrating the cable as it appears before the machine has been in operation so that the cable has a cylindrical sheath surface.

When the machine is in operation the thermal expansion causes the outer shape of the cable 6 to adjust to the shape of the ribbed sheath 212 since expansion occurs only in the spaces formed between the depressions 214. This is illustrated in the lower part of Figure 10 where the cable fills out the sheath and follows its contours. Since these spaces must be able to take up the entire expansion, the depth of the depressions must naturally be correspondingly greater than the increase in diameter the cable would have if it had been able to expand uniformly in longitudinal direction.

The fact that the space outside the sheath is filled out during operation assures the heat transfer from the cable to the surroundings. When the cable cools down during an interruption in operation it will to a certain extent retain its profiled outer surface.

When the stator is wound at manufacture the sheath 212 is first fitted onto the cable 6. A water-based lubricant such as a 1% polyacrylamide may be used. The cable is then passed through the slot 5 by pulling on the sheath. The corrugations
5 cause the sheath 212 to stretch and it is thus compressed in radial direction so that its outer diameter is decreased. A clearance is thus obtained through the wall of the slot 5, thereby facilitating insertion. Once in place, when the tensile force is no longer applied, the sheath expands so that its ridges 213 lie in contact with the slot wall as shown in Figures 4 and 5.

10 Another method is to thread the sheath 212 into the slot 5 by pulling on the sheath. The corrugations then cause the sheath to stretch and it is thus compressed in radial direction so that its outer diameter is decreased. A clearance is thus obtained in relation to the wall of the slot 5, thereby facilitating insertion. Once in
15 place, when the tensile force is no longer applied, the sheath expands so that its ridges 213 lie in contact with the slot wall as shown in Figures 9 and 10.

The cable is then drawn into the sheath which is positioned, possibly using a water-based lubricant such as 1% acrylamide.

20 The casting compound 215 is then introduced into the spaces outside the sheath and this is secured to the slot walls by the casting compound. The longitudinal cooling tubes 216 may be embedded in casting compound at the same time. The casting compound 215 transfers the heat from the cable to the surroundings and/or
25 the cooling tubes 216. Casting the sheath in this way also ensures that it is positioned in axial direction and, thanks to its corrugated shape the cable is axially secured in the sheath. The cable is thus firmly held in the slot even if the machine is oriented with vertical axis.

30 Figure 11 shows an alternative arrangement of the corrugations on the cable surrounding the sheath surface. This differs from the embodiments described earlier primarily in that the corrugations are produced directly in the outer semiconducting layer 234a of the cable 6. The outer semiconductor layer consists
35 of an ethylene copolymer with soot particles embedded in the material in a quantity dictated by the conductivity aimed at in the layer. In conventional semiconductor layers, i.e. with cylindrical outer surface, the layer is normally

thicker than about 1 mm. In the embodiment shown in Figure 11, it has a thickness in the depressions that is less than the "normal" thickness and a thickness in the tops that exceeds this. With a reference thickness of 1 mm, for instance, of a circular layer, the corresponding corrugated layer has a thickness of
5 0.5 mm in the depressions and 1.5 mm in the tops.

The cable illustrated in Figure 11 thus lies in the slot with direct contact between the tops 14a of the corrugations and the slot wall. Since the semiconductor layer is thicker there, a certain amount of damage can be tolerated to the semiconductor
10 layer to those parts upon insertion of the cable and as a result of vibration during operation, without injurious consequences. Furthermore, the contact between cable and tops 14a also provides a certain stabilization so that the problem of vibration is reduced.

15 During operation the thermal expansion of the cable will result in the cable expanding only in the free spaces between the corrugations, and these will be substantially filled by the semiconductor material. The expansion force will also cause the contact pressure at the tops to increase and the clamping action to be intensified. The material of the semiconductor layer is deformed substantially
20 elastically at temperatures around 20°C, whereas at high temperatures from about 70°C and upwards the deformation will be increasingly plastic. When the cable cools down at an interruption in operation, therefore, its outer semiconductor layer will retain a certain deformation, thereby having less height at the corrugations.

25 In the embodiment according to Figures 8-10, where the corrugations are arranged on a separate sheath, they may of course be arranged longitudinally instead, and in the embodiment according to Figure 11 the corrugations may be annular instead of longitudinal.

30 In both cases the corrugations may have some other appearance, e.g. helical. The corrugations may also run in two dimensions. The profile of the corrugations may be sinus-shaped as in Figures 8-10 or may have sharp edges as in Figure 6, regardless of the direction they run in and regardless of whether they are arranged on a separate sheath or directly in the outer semiconductor layer.

The corrugated sheath surface may also be formed using separate elements, e.g. longitudinal rods of polyamide arranged along the cable and distributed around its periphery. These rods together with the outer semiconducting layer then form a corrugated sheath surface in which the tops are formed by the rods and the
5 depressions by the surface of the semiconductor layer.

The embodiment with corrugated sheath surface is suitable for slots with arbitrary profile of the slot walls, radially flat walls as in Figure 9, corrugated walls as in Figure 1, or some other suitable shape.

10 Figure 12 shows an enlarged section through a part of a stator slot 5. The slot is of substantially the type shown in Figure 1. One difference is that some of the waist parts 8, i.e. the narrower parts that separate the cable lead-throughs 6, are one-sided. Thus alternate narrower parts 8b have constrictions on both sides so that
15 the narrow part is substantially symmetrical, and alternate narrower parts 8a have a constriction on only one side, the other side lying in the tangential plane 9 to adjacent arc-shaped wide parts. In longitudinal direction, therefore, the slot 5 will comprise parts having three different widths; the wide circular parts 7, the single-sided waist parts 8a and the even narrower double-sided waist parts 8b. As in
20 Figure 1, the slot 5 is also composed of sections 51, 52, 53 of different widths.

The arrangement of the single-sided waist parts 8a provides extra space in the slot for pressure elements 313. The pressure element 313 illustrated in the figure consists of a hose extending axially through the slot, i.e. parallel with the cable
25 lead-throughs 6. The pressure element 313 is filled with pressure-hardened silicon or urethane rubber 312 which presses the hose out towards adjacent surfaces, acquiring a shape conforming to these surfaces upon hardening. The hose thus acquires a substantially triangular cross-section, with a first surface 11a supporting the slot wall, a second concave arc-shaped surface 311b abutting one of the
30 adjacent cable lead-throughs 6b and a third surface 311c having the same shape as the second but abutting another of the adjacent cable lead-throughs 6a. Arranged in this manner, the pressure element 313 simultaneously presses the two cable lead-throughs 6a and 6b against the opposite slot wall with a force on each cable lead-through 6a, 6b that is directed substantially towards its centre.

35

A sheet 314 of rubber or similar material is arranged on the opposite slot wall in the example shown.

5 The sheet 314 is applied to absorb a part of the thermal expansion. However, the element 313 may be adapted to enable absorption of all the thermal expansion, in which case the sheet 314 is omitted.

10 Several different variants for the slot profile are applicable besides those illustrated in Figures 1 and 12. A few examples are illustrated in Figures 13-15, where Figure 13 shows a slot shape in which the narrow parts 8 are one-sided, i.e. one side of the slot is completely flat, whereas the other protrudes into every waist part. Support elements 313 are arranged at alternative narrow parts 8. Alternatively support elements may be arranged in every narrow part 8. All support elements 313 are situated close to the flat slot wall.

15 In Figure 14 every narrow part 8 is similarly one-sided, i.e. formed by a flat part of one slot wall constituting a tangent to adjacent wide parts on the other side of a protruding wall section, the flat and protruding parts being situated alternately on each side of the slot. The support elements 313 are situated at each tangent plane part of the wall.

20 In Figure 15 alternate narrow parts 8 are double-sided, i.e. with protruding wall sections on both sides of the slot, whereas alternate narrow parts are single-sided with one wall part constituting a tangent plane, their positions alternating between the two sides of the slot. The sealing elements 313 are situated at these tangent plane parts.

25 Figure 16 illustrates an embodiment of the support element 313 consisting of a thin-walled outer hose 323 and a thin-walled inner hose 315, both of rubber or some other elastic material. The hoses have such thin walls that they are easily deformed, becoming slippery and easily inserted axially into the elongated space between cable and slot wall.

30 When the hoses 323, 315 are in place the space between them is filled with a curable elastic rubber material, e.g. silicon rubber 316, below which the inner hose 15 is kept filled with compressed air. When the silicon rubber 316 has solidified a

thin-walled hose is obtained which presses against cable and slot wall and which has a certain elasticity in order to absorb thermal expansion of the cable. The inner hose 315 may be concentric with the outer hose, but is suitably eccentrically situated. When the element 313 is expanded by being filled with silicon rubber, it will adapt to the cross-sectional shape of the available space, becoming a rounded-off triangular shape as shown in Figures 12-15. The cavity formed by the inner hose contributes to increasing the elasticity of the support element 313 which, if it were completely filled with silicon rubber, would not be sufficiently compressible. The inner hose 315 may either remain after the space has been filled and the material hardened, or it may be pulled out.

Figure 17 shows two embodiments of the support element 313 in which the upper alternative corresponds to the support element applied as described with reference to Figure 16.

The lower part of Figure 17 illustrates another embodiment in which, upon application, the inner hose is replaced with a rod-shaped filler profile 317. The support element is formed in similar manner to the embodiment according to Figure 16 but with the difference that the outer thin-walled hose is inserted enclosing the filler profile 317 instead of the inner thin-walled hose. After that the silicon rubber has been sprayed into the space between the hose and the surrounding thin-walled hose and has hardened, the filler profile 317 is pulled out of the support element so that a space of corresponding shape is formed. The filler profile 317 may have a suitable profile and be provided, for instance, with longitudinal grooves 322 in order to orientating the space optimally and achieve the desired elasticity. The filler profile 317 is suitably surface-treated to facilitate its removal.

Figure 18 illustrates yet another method of applying the support element 313 in the space between cable and slot wall. The element here comprises a round rubber rod with a diameter in unloaded state that is greater than can be inserted into the cross-section of the available space. Its unloaded shape is illustrated by the circle 318. To enable insertion of the rod, it is pulled out in longitudinal direction so that its cross-sectional area decreases to the equivalent of the circle 319. It can then be pulled through the available space. When it is in place the tensile stress is removed so that it contracts axially and expands in cross-sectional direction. It

will then contact the slot wall and adjacent cable parts with a compressive force and assume the triangular cross-sectional shape designated 320.

Figures 19-21 illustrate another embodiment showing how the support element 313 may be applied, where upon insertion the support element is forced to assume such a cross-sectional shape that it may be inserted without obstruction into the available space.

In Figure 19 the support element consists of a hose which is placed under vacuum suction so that it acquires the flat shape shown in the figure, and is then sealed. When the hose is in place, air is allowed in by cutting off the ends of the hose so that it expands to abutment with cable and slot wall. The thickness of the hose is chosen so that its inherent cross-sectional rigidity when the hose is no longer vacuum-sealed, is designed to achieve sufficient pressure and permit thermal expansion of the cable.

In Figure 20 a hose similar to the one in Figure 19 is glued flat against a flat strip 321, e.g. of glassfibre laminate, with a brittle glue. When the flat hose has been inserted compressed air is blown in so that the brittle glue snaps and the hose assumes a shape in which it abuts slot wall and cable.

Alternatively, as illustrated in Figure 21, glue is inserted into the hose which is then rolled flat so that it is glued in a state equivalent to that shown in Figure 19. When in place, compressed air is blown into the hose so that the glue joint is broken. The hose containing glue may alternatively be rolled to a different shape, e.g. to the shape shown in Figure 21.

The forcibly flattened shape of the support element upon insertion, as illustrated in Figures 19-22, means that in this embodiment it is also possible to insert it before the cable is wound, in which case the flat shape is retained until the cable lead-throughs are in place.

The embodiments shown in Figures 19-21 are based on the thickness of the tube being sufficient, once the forcible deformation has been released, for its inherent spring action to provide suitably resilient pressure against the cable lead-throughs.

- In yet another alternative embodiment the walls of the hose can be made thinner than shown in Figure 19, in which case it is under vacuum during insertion and will expand when the hose is in place and the vacuum is released. In this embodiment the hose is subsequently filled with a pressure medium to give it
- 5 sufficient contact pressure. This medium may be air or liquid, e.g. water. The function of the support element is thus reversible since this pressure can be relieved. Alternatively, the hose may be filled with a cold-hardening medium such as silicon rubber, in which case the pressure will be permanent.
- 10 In the latter embodiment the support element is placed asymmetrically in the slot. A symmetrical arrangement as illustrated in Figure 22, in which each support element 313 is placed mid-way between two cable lead-throughs, is also within the scope of the invention.

CLAIMS

1. A rotating electric machine comprising a stator with windings (6) drawn through slots (5) in the stator (1), characterized in that at least one winding (6) comprises an insulation system comprising at least two semiconducting layers (32, 34), each layer essentially constituting an equipotential surface, and also including solid insulation (33) between these layers (32, 34) and in that support members (13, 113, 212, 213) are arranged along and in contact with the winding (6).
2. A machine as claimed in claim 1, in which at least one of said layers (32, 34) has substantially the same coefficient of thermal expansion as the solid insulation (33).
3. A machine as claimed in claim 1 or claim 2, the stator winding of which comprises high-voltage cables (6) wherein each lead-through of the cable through a slot (5) is in the following designated a cable lead-through, members (13, 113) being arranged for resilient fixation of each cable lead-through in each slot (5), said members (13, 113) comprising means exerting pressure against each cable lead-through, said pressure means arranged between the cable lead-through and at least one side wall of the slot (5) and spring means arranged between the cable lead-through and at least on side wall of the slot, said pressure means comprising a plurality of elongate pressure elements running in the direction of the cable lead-through.
4. A machine as claimed in claim 3, arranged for direct connection to a power network without intermediate transformers.
5. A machine as claimed in claim 3 or claim 4, wherein each of said pressure elements is in the form of a tube comprising a sleeve containing pressure-hardened material.
6. A machine as claimed in claim 5, wherein said material is epoxy.

7. A machine as claimed in claim 3 or claim 4, wherein each of said pressure elements is in the form of a tube comprising a sleeve containing pressurized fluid.

5 8. A machine as claimed in any of claims 3-7, wherein at least the majority of said pressure elements exert pressure on two adjacent cable lead-throughs.

10 9. A machine as claimed in any of claims 3-7, wherein an axial section of said slot exhibits a profile with varying cross section in which each side surface of the slot immediately opposite each cable lead-through has a circular portion corresponding to the outer diameter of the cable and, between these circular portions, has waist parts where the slot width is less, said pressure elements being arranged in said waist parts.

15 10. A machine as claimed in claim 9, wherein at least some of said waist parts are single-sided waist parts defined by the fact that one slot wall comprises a tangential plane to said circular portions and the part of the other slot wall immediately opposite comprises a connecting plane situated between and
20 substantially parallel to the corresponding tangential plane and a plane connecting the centres of the circular portions, said pressure element being arranged at the slot wall constituting a tangential plane.

25 11. A machine as claimed in any of claims 3-10, wherein all pressure elements in a slot are arranged at one and the same wall of the slot.

12. A machine as claimed in any of claims 3-11, wherein said pressure members and said resilient members are arranged close to the same slot wall, the resilient members being joined to the pressure members.

30 13. A machine as claimed in any of claims 3-12, wherein said pressure members and said resilient members are arranged close to different walls of the slot.

14. A machine as claimed in claim 13, wherein said resilient member consists of a sheet of elastic material.

5 15. A machine as claimed in claim 14, wherein said sheet is provided with slots .

16. A machine as claimed in claim 12, wherein said resilient members comprise pads of elastic material applied on the pressure member.

10 17. A machine as claimed in claim 16, wherein said pads are provided with slots .

15 18. A machine as claimed in claim 1 or claim 2, wherein the windings (6) consist of high-voltage cable (6), a corrugated sheath (212) surrounding at least some of the cable lead-throughs through the slots.

19. A machine as claimed in claim 18, wherein the corrugated sheath (212) surrounds the cable (6) continuously around its entire circumference and along its entire axial length in the slot (5).

20 20. A machine as claimed in claim 18 or claim 19, wherein the largest diameter of the corrugated sheath (212) is substantially equal to the width of the slot (5) and wherein the depth (d) of the corrugations is sufficient to absorb thermal expansion of the cable (6) during operation.

25 21. A machine as claimed in any of claims 18-20, wherein the corrugated sheath (212) is formed from a deformable preferably elastically deformable material.

30 22. A machine as claimed in any of claims 18-21, in which a casting compound (215) is arranged between the corrugated sheath (212) and the slot.

35 23. A machine as claimed in any of claims 18-22, wherein the corrugated sheath (212) is formed from a separate tubular corrugated sheath applied around the outer semiconductor layer (34) of the cable.

24. A machine as claimed in claim 23, wherein the corrugations (212) are annular.
- 5 25. A machine as claimed in any of claims 18-21, wherein the corrugated sheath surface is formed of corrugations (212a) in the outer semi-conducting layer (34a) of the cable (6).
- 10 26. A machine as claimed in claim 25, wherein the corrugations (212a) run in the longitudinal direction of the cable (6).
- 15 27. A machine as claimed in claim 1 or claim 2, wherein the windings consist of high-voltage cable (6) and wherein an elongated elastic support element (313) is arranged along and in contact with at least one cable lead-through (6) in at least one of the slots.
- 20 28. A machine as claimed in claim 27, wherein the support element (313) extends along the entire axial extension of the stator.
- 25 29. A machine as claimed in claim 27 or claim 28, wherein the support element (313) constitutes a hose.
- 30 30. A machine as claimed in claim 29, wherein the hose (313) encloses a pressure medium (312).
- 35 31. A machine as claimed in claim 30, wherein the pressure medium is a fluid.
32. A machine as claimed in claim 31, wherein the hose (313) is sealed at both ends.
33. A machine as claimed in claim 31, wherein the pressure fluid communicates with a pressure source.
34. A machine as claimed in claim 30, wherein the pressure medium (312) consists of an elastic material in solid form.

35. A machine as claimed in claim 34, wherein the elastic medium has a cavity running axially through it.

5 36. A machine as claimed in claim 35, wherein the cavity has non-circular cross- section.

37. A machine as claimed in any of claims 27-36, wherein each slot (5) in a radial plane has a profile with wide (7) and narrow (8) parts alternating in radial
10 direction.

38. A rotating electric machine as claimed in claim 37, wherein the narrow parts (8) are asymmetrical in relation to a central plane running radially through the slot.
15

39. A rotating electric machine as claimed in claim 38, wherein each narrow part (8) is mirror-inverted in relation to the nearest adjacent narrow part (8) seen in the direction of said radial plane

20 40. A rotating electric machine as claimed in any of claims 27-39, wherein each support element (313) abuts two cable lead-throughs (6).

41. A rotating electric machine with magnetic circuit for high voltage in which the magnetic circuit comprises a magnetic core and a winding, characterized in that the winding (6) consists of a cable (6) comprising one or more current-carrying conductors (6), each conductor consisting of a number of strand parts (31), that around each conductor (6) is arranged an inner semiconducting layer (32), around which is arranged an insulating layer of solid insulation (33), around which is arranged an outer semiconducting layer (34) and in that support members (13, 113, 212, 313) are arranged along the windings (6), said support members being arranged along and in contact with the windings (6).
25
30

42. A machine as claimed in claim 41, including the features defined for machines as claimed in any of claims 2-40.
35

43. A method for manufacturing a machine as claimed in claim 1 or claim 41, characterized in that at least one elongated support element is inserted and orientated axially in at least one of the slots.

5 44. A method as claimed in claim 43, wherein hose-like elements are inserted in the slots and oriented axially, after which the hose-like elements are filled with a pressure medium.

45. A method as claimed in claim 44, wherein the hose-like elements are
10 filled with a curable material which is allowed to harden under pressure.

46. A method as claimed in claim 44, wherein hose-like elements are filled with epoxy.

15 47. A method as claimed in any of claims 44-46, wherein the hose-like elements are inserted after the cable windings have been applied.

48. A method as claimed in any of claims 44-47, wherein a single hose-like element is inserted so that it extends in several loops to and fro through the
20 slots.

49. A method as claimed in claim 43, wherein the cable is surrounded by a corrugated sheath before it is inserted through the slot.

25 50. A method as claimed in claim 49, wherein the cable is surrounded by a corrugated sheath surface by applying a separate tubular corrugated sheath around the cable before it is inserted into the slot.

51. A method as claimed in claim 49, wherein the cable is surrounded by a
30 corrugated sheath by applying a separate tubular corrugated sheath in the slot before the cable is inserted into the slot.

52. A method as claimed in claim 50, wherein the sheath is applied on the cable in axial direction and a lubricant is used during application.

53. A method as claimed in any of claims 50-52, wherein a casting compound is inserted between the sheath and the walls of the slot.
54. A method as claimed in claim 53, wherein axial cooling tubes are cast
5 in the casting compound.
55. A method as claimed in any of claims 50-54, wherein the sheath applied has annular corrugations.
- 10 56. A method as claimed in any of claims 50-54, wherein the sheath applied has corrugations running helically.
57. A method as claimed in claim 49, wherein the cable is surrounded by a corrugated sheath surface, the cable being manufactured such that the outer semi-
15 conducting layer is provided with corrugations .
58. A method as claimed in claim 57, wherein the cable is manufactured such that its corrugations run in longitudinal direction.
- 20 59. A method as claimed in claim 57 or claim 58, wherein the outer semi-conducting layer of the cable is extruded.
60. A method as claimed in claim 43, wherein the support element is inserted in axial direction, after the cable has been wound.
25
61. A method as claimed in claim 60, wherein the support element is inserted into a space formed between at least one cable lead-through(word) and at least one wall of the slot and, during application the support element is caused to assume a state enabling it to pass without obstruction or resistance through the
30 profile formed by said space in an axial cross- section, after which, when it has been inserted and positioned in said space, the support element is caused to expand transversely to the axial direction.
62. A method as claimed in claim 61, wherein the support element
35 comprises a thin-walled elastic hose which is decompressed at insertion and the

thinness and elasticity of which is sufficient for the hose to be deformed without noticeable resistance, thereby allowing passage through said profile of the space.

5 63. A method as claimed in claim 62, wherein at insertion the support element surrounds an elongated body along the entire length of the hose, said body having a cross-sectional dimension such that a space is formed between the hose and the body, said space being filled with a hardening elastic material when the support element is in place in the slot, so that the hose expands transversely to the axial direction.

10

64. A method as claimed in claim 63, wherein the elongated body consists of an inner, thin-walled hose which is filled with a pressure medium before said space is filled.

15

65. A method as claimed in claim 62, wherein the elongated body consists of a rod element, which rod element is removed when the space has been filled and said material has hardened.

20

66. A method as claimed in claim 65, wherein the rod element has a profile with longitudinal ridges.

25

67. A method as claimed in claim 61 wherein, prior to insertion, the support element is given a cross-sectional profile with clearance to the cross-sectional profile of said space, thereby allowing passage.

30

68. A method as claimed in claim 63, wherein at insertion the support element is subjected to axial tensile force to reduce its cross-sectional profile and thereby allow passage, the tensile force being released when the support element is in position, thus achieving said expansion.

35

69. A method as claimed in either of claims 60-61, wherein the support element consists of a hose which at insertion is caused to assume a forcibly deformed state and which, when the hose is in place, is released from the deformed state.

70. A method as claimed in claim 69, wherein the deformed state is achieved by gluing the hose in a deformed state and releasing the adhesive joint when the hose is in place.

5 71. A method as claimed in claim 69, wherein the deformed state is achieved by the interior of the hose being subjected to negative pressure and the negative pressure being released when the hose is in place.

10 72. A method as claimed in claim 61, wherein the support element consists of a hose having a cross-sectional profile that is less than the cross-sectional profile of said space and that when the element is in place the hose is filled with a pressure medium.

15 73. A method as claimed in claim 72, wherein the pressure medium is a cold-setting material.

20 74. A method as claimed in claim 72, wherein the pressure medium is a gas or a liquid and the hose is sealed at its ends when it has been filled with the pressure medium.

25 75. A method as claimed in claim 72, wherein the pressure medium is a gas or a liquid and wherein this is supplied so that communication can be maintained between the medium and the pressure source even after the machine is in operation.

76. A method as claimed in claim 72, wherein the pressure medium is a rod-shaped body which is inserted through the hose and expands it.

1/6

Fig. 1

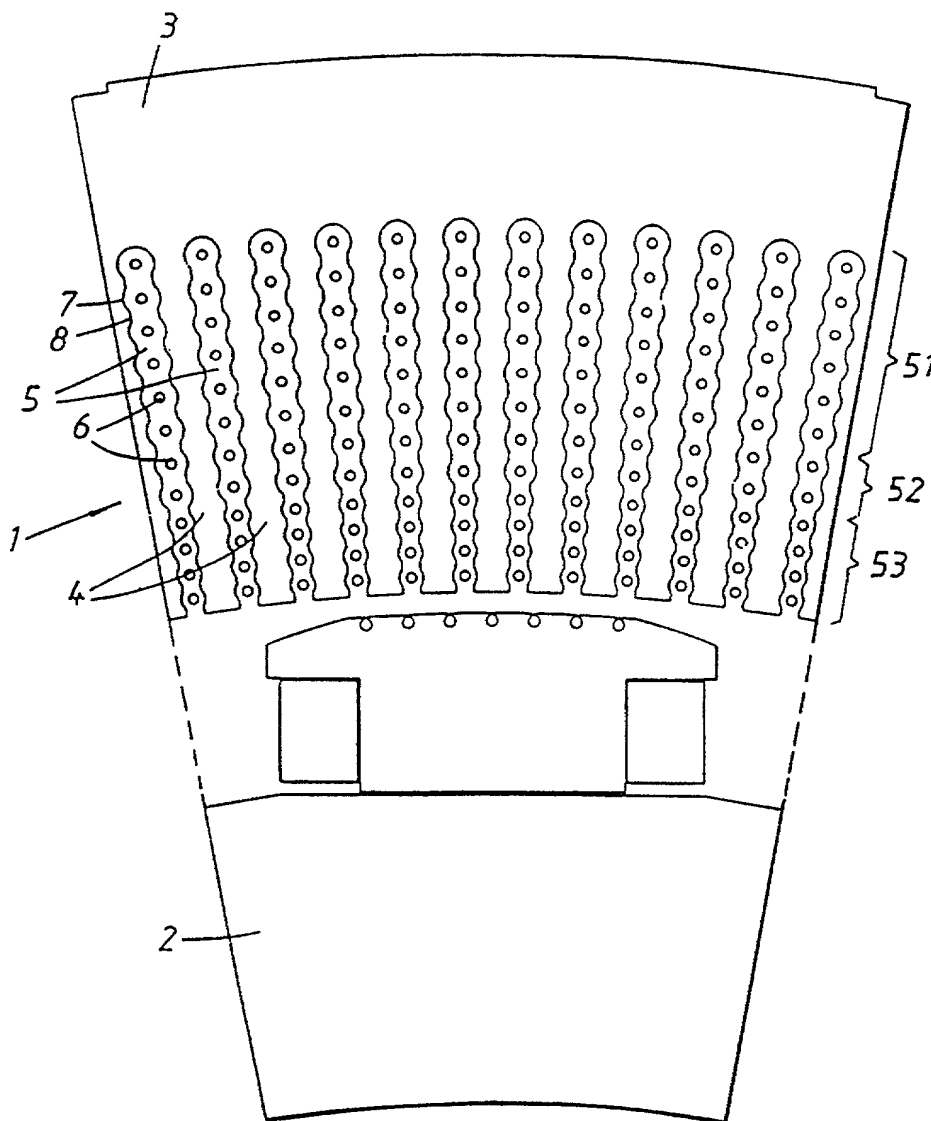
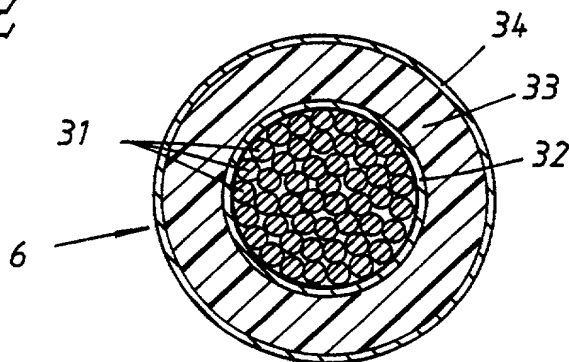


Fig. 2



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Fig. 5

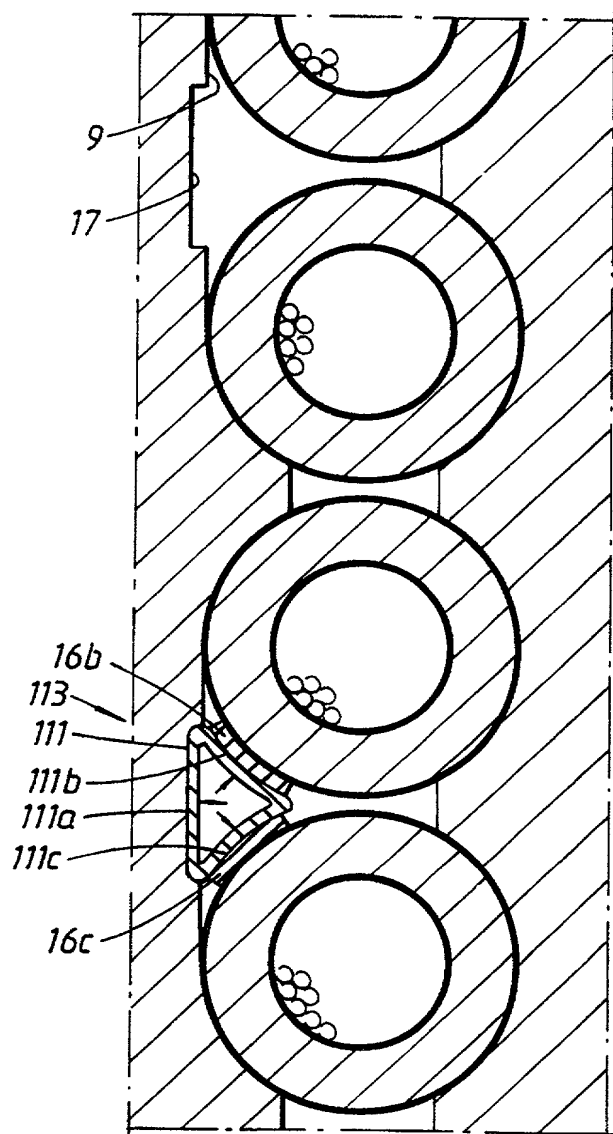


Fig. 6

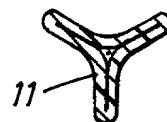
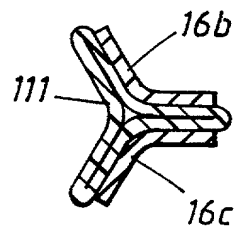
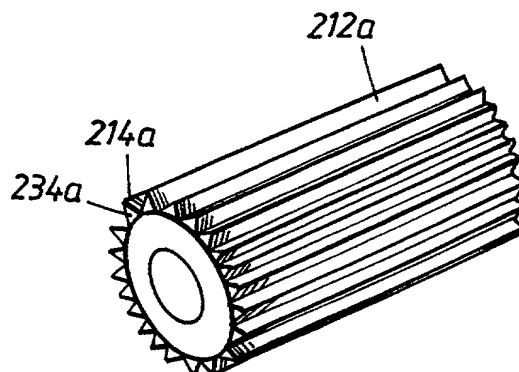
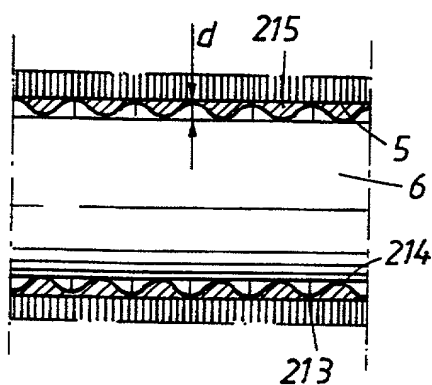
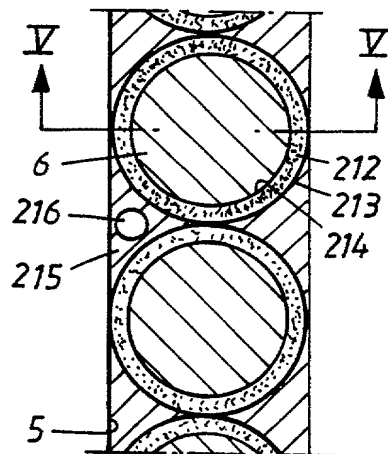
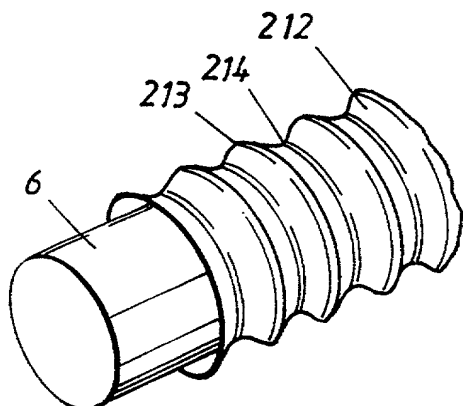
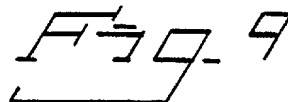
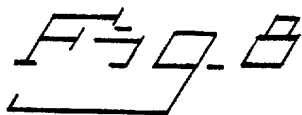


Fig. 7





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Fig. 12

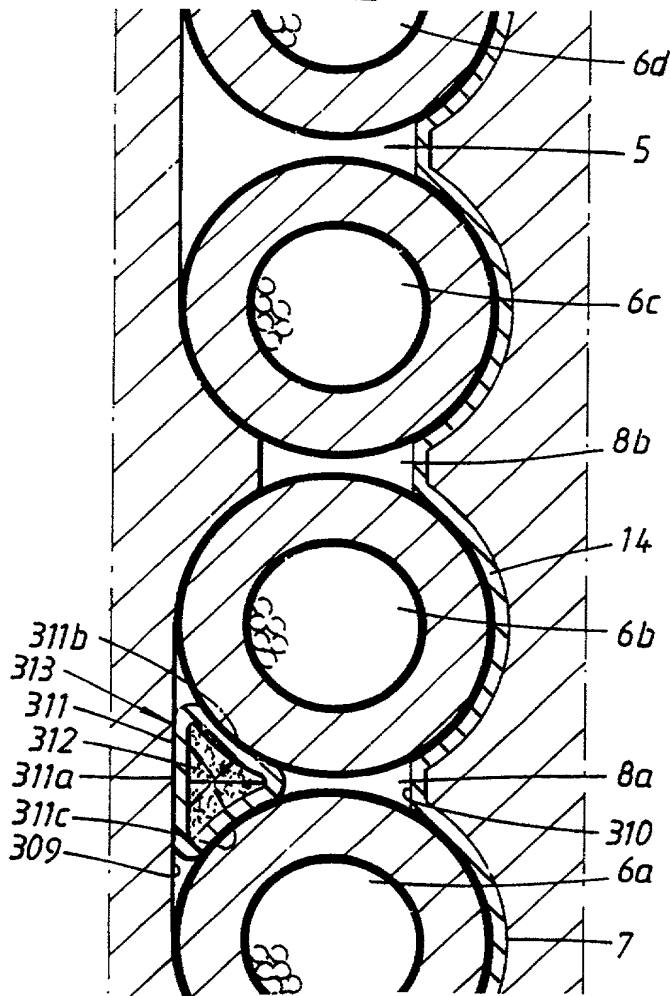


Fig. 13

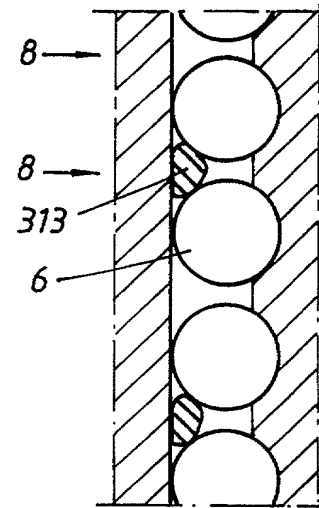


Fig. 15

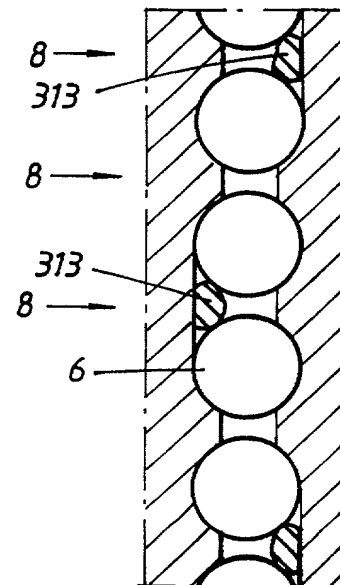
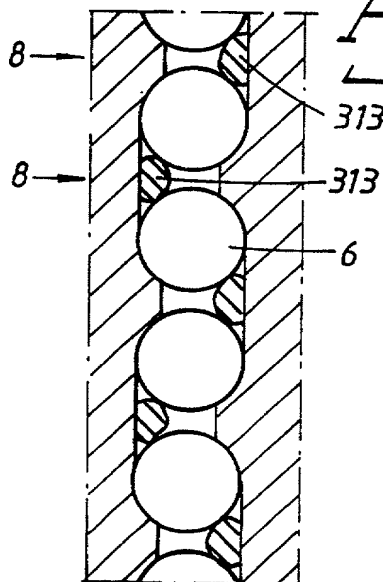


Fig. 14



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Fig. 16

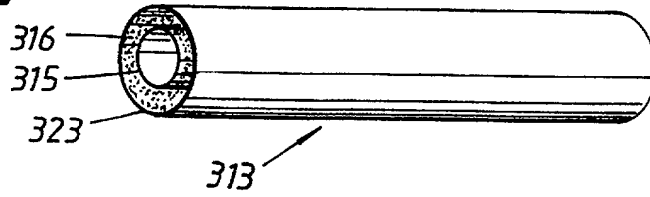


Fig. 17

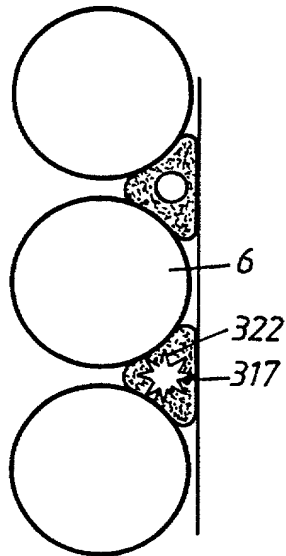


Fig. 18

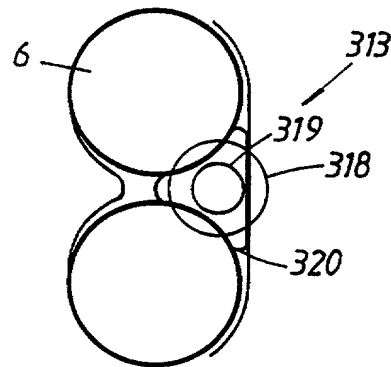


Fig. 19



Fig. 20

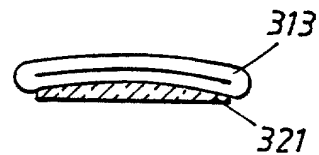
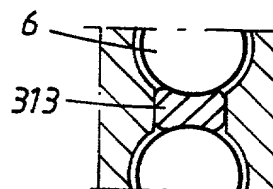


Fig. 21



Fig. 22



Declaration, Power Of Attorney and Petition

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WE (I) the undersigned inventor(s), hereby declare(s) that:

My residence, post office address and citizenship are as stated below next to my name,

We (I) believe that we are (I am) the original, first, and joint (sole) inventor(s) of the subject matter which is claimed and for which a patent is sought on the invention entitled

ROTATING ELECTRICAL MACHINE COMPRISING HIGH-VOLTAGE STATOR
WINDING AND ELONGATED SUPPORT DEVICES SUPPORTING THE WINDING AND
METHOD FOR MANUFACTURING SUCH MACHINE
 the specification of which

☐ is attached hereto.

☒ was filed on _____ as
 Application Serial No. _____
 and amended on _____.

☒ was filed as PCT international application
 Number PCT/SE97/00897
 on 27 May 1997,
 and was amended under PCT Article 19
 on _____ (if applicable).

We (I) hereby state that we (I) have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

We (I) acknowledge the duty to disclose information known to be material to the patentability of this application as defined in Section 1.56 of Title 37 Code of Federal Regulations.

We (I) hereby claim foreign priority benefits under 35 U.S.C. § 119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed. Prior Foreign Application(s)

Application No.	Country	Day/Month/Year	Priority Claimed
<u>9602079-7</u>	<u>SWEDEN</u>	<u>29 May 1996</u>	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
<u>9602085-4</u>	<u>SWEDEN</u>	<u>29 May 1996</u>	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
<u>9604031-6</u>	<u>SWEDEN</u>	<u>04 November 1996</u>	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
<u>9700362-8</u>	<u>SWEDEN</u>	<u>03 February 1997</u>	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

We (I) hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below.

(Application Number)

(Filing Date)

(Application Number)

(Filing Date)

We (I) hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s), or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

Application Serial No.

Filing Date

Status (pending, patented,
abandoned)

PCT/SE97/00897

27 May 1997

And we (I) hereby appoint: Norman F. Oblon, Registration Number 24,618; Marvin J. Spivak, Registration Number 24,913; C. Irvin McClelland, Registration Number 21,124; Gregory J. Maier, Registration Number 25,599; Arthur I. Neustadt, Registration Number 24,854; Richard D. Kelly, Registration Number 27,757; James D. Hamilton, Registration Number 28,421; Eckhard H. Kuesters, Registration Number 28,870; Robert T. Pous, Registration Number 29,099; Charles L. Gholz, Registration Number 26,395; Vincent J. Sunderdick, Registration Number 29,004; William E. Beaumont, Registration Number 30,996; Steven B. Kelber, Registration Number 30,073; Robert F. Gnuse, Registration Number 27,295; Jean-Paul Lavalleye, Registration Number 31,451; Stephen G. Baxter, Registration Number 32,884; Martin M. Zoltick, Registration Number 35,745; Robert W. Hahl, Registration Number 33,893; Richard L. Treanor, Registration Number 36,379; Steven P. Weihrouch, Registration Number 32,829; John T. Goolkasian, Registration Number 26,142; Marc R. Labgold, Registration Number 34,651; William J. Healey, Registration Number 36,160; Richard L. Chinn, Registration Number 34,305; Steven E. Lipman, Registration Number 30,011; Carl E. Schlier, Registration Number 34,426; James J. Kulbaski, Registration Number 34,648; Catherine B. Richardson, Registration Number 39,007; Richard A. Neifeld, Registration Number 35,299; J. Derek Mason, Registration Number 35,270; and Surinder Sachar 34,423; our (my) attorneys, with full powers of substitution and revocation, to prosecute this application and to transact all business in the Patent Office connected therewith; and we (I) hereby request that all correspondence regarding this application be sent to the firm of OBLON, SPIVAK, McCLELLAND, MAIER & NEUSTADT, P.C., whose Post Office Address is: Fourth Floor, 1755 Jefferson Davis Highway, Arlington, Virginia 22202.

We (I) declare that all statements made herein of our (my) own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

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